ZOOGOER

JANUARY • FEBRUARY 1991

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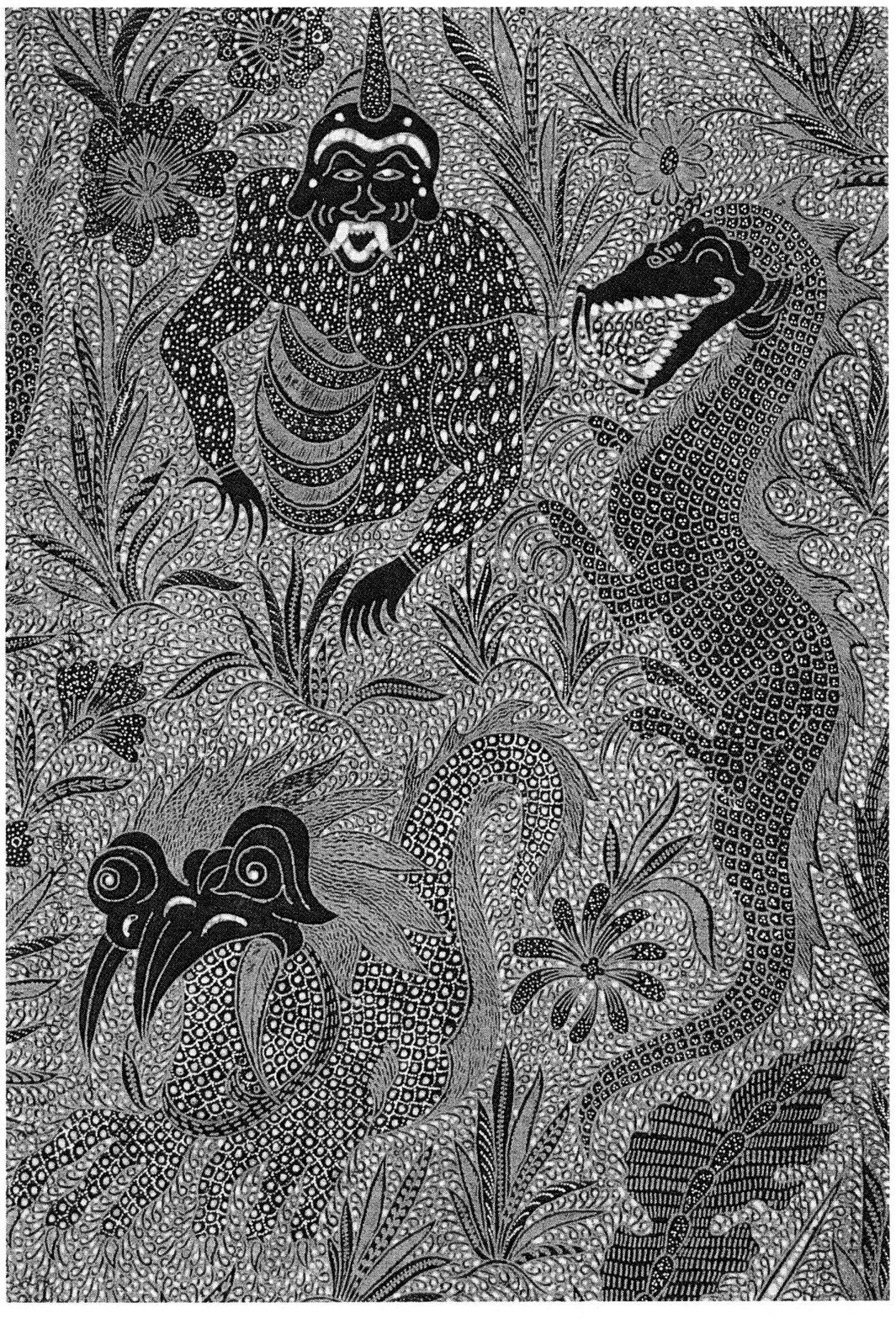

Kain Panjang (long cloth). Central Java, ca 1945. (The Textile Museum, Washington, D.C. 1985.51.3 [Detail]. Gift of Katharine Z. Creane.)

FEATURES

DEPARTMENTS

Friends of the National Zoo

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

ZooGoer [ISSN 0163-416X] is published six times a year by Friends of the National Zoo to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. The nonmember subscription rate is $12 a year. Third class mailing permit no. 6282.

The National Zoological Park is located in the 3000 block of Connecticut Avenue, N.W., Washington, D.C. 20008, 202-673-4717. Weather permitting, the Zoo is open every day except Christmas. Hours: From September 16 to April 30, grounds are open from 8:00 a.m. to 6:00 p.m.; buildings, 9:00 a.m. to 4:30 p.m. From May 1 to September 15, grounds are open from 8:00 a.m. to 8:00 p.m.; buildings, 9:00 a.m. to 6:00 p.m.
Director: Michael H. Robinson.

Membership in FONZ entitles you and your family to many benefits:publications, discount privileges, and invitations to special programs and activities to make your zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, D.C. 20008, or call 202-673-4960.

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Cover: Red wolf *(Canis rufus).* (Photo by Phillip Jones.)

An Environmental Report Card for 1990

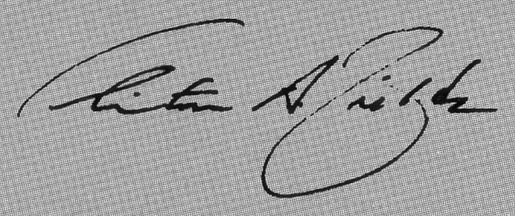
In 1989, Friends of the National Zoo committed itself to a new program in environmental conservation. FONZ had long promoted, supported, and educated about wildlife conservation, but I realized then that conservation truly begins at home. While we worried about the endangered fauna and disappearing habitats of far-off places, our own local environment was being degraded. I also became aware of the linkages between our own wasteful and polluting habits and worldwide environmental problems. The program we put in place to address these issues has two components: educating our members, Zoo visitors, and the general public about environmental conservation, and changing FONZ's own practices to make them more environmentally sound.

I am pleased to report progress on both of these fronts in 1990. Our education goals were achieved with increased coverage of environmental issues in *ZooGoer;* with regular features in *Wildlife Adventures* and in our staff and volunteer newsletters on sound environmental practices in the home; and through the distribution of a brochure, "10 Ways You Can Help Your Habitat," to more than 30,000 people visiting the Zoo. Our Earth Day celebration, which featured a recycling demonstration by the Zoo's elephants, who crushed aluminum cans brought by Zoo visitors, delivered the conservation message to thousands more. In addition, the Zoo Bookstore stocked an increasing number of books on environmental conservation and, with the Gift Shops, began to offer such environmentally sound products as canvas shopping bags, while reducing the number of plastic trinkets.

Internally, FONZ's office stationery was printed on recycled paper in 1990, as were ZooFari publications and promotional material, the FONZ annual report, and our holiday greeting cards. At the same time, we continued to recycle all office paper and aluminum cans. Food Service greatly reduced its use of plastic products, eliminated CFC-producing food packaging, reduced use of detergents, and now buys only line-caught albacore tuna.

I am proud of our progress, but much remains to be done. Our goals for 1991 include: continuing our education program; using recycled paper for more of our printed material, in particular for our member-acquisition mailings; recycling cardboard and packing material; and reducing our use of fossil fuels. But perhaps most exciting is a planned joint education program with Reynolds Aluminum Recycling Company. In this program, dubbed "Be Nice, Twice," FONZ will encourage people, first, to reduce waste by recycling their aluminum cans at the Zoo or at Reynolds recycling centers and, second, to donate the proceeds to help the animals at the Zoo. In addition, Reynolds will donate a penny for each pound of aluminum recycled by Zoo supporters. I hope each and every one of you will participate and "be nice, twice."

I also ask that you send me your suggestions about how FONZ can improve and expand its environmental conservation initiatives. We rely on our members for ideas, inspiration, and involvement, so that, working together, FONZ can make a real difference to the state of our world.



Clinton A. Fields
Executive Director

Errata

In the article on rainforest cucumbers in the November-December ZooGoer, *the flower on page 25 is a rainforest cucumber flower. Both flowers pictured on page 24 should be hanging downward. Also, we did not mean to imply that spiders are insects on page 24.*

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IN THE FLOODED FOREST

Pat Janowski

The pacu (*Colossoma nigripinnis*), one of several varzea fishes that surface to take oxygen from the air. *(Photo by Patrice Ceisel.)*

Outside of Manaus, Brazil, where the ink-black Rio Negro joins the cafe-au-lait Solimoes, we are skidding over the water in a sort of motorized canoe on our way to the flooded forest. It is mid-April, during the rainy season, and the waters of the Amazon River have already begun to rise. Though the two rivers will continue to flow side by side for miles, unmixed expanses of black and tan, their seam ruptures at this close vantage point, in huge eddies and swirls.

We cross the boundary and start up the Solimoes, the upper Amazon that stretches from this point of confluence to the Peruvian border. *Caboclos* (people of mixed Portuguese and Indian ancestry) on the bank to our right are washing clothes in the silt-filled water; they pause and stare as we go by.

Christopher Martius points out that the bank is actually an island, which now serves as home and farm to these Brazilians and their animals. This particular island will be completely underwater by the time the river reaches its peak in late June. A scientist with the Max Planck Institute's floating laboratory since 1985, Chris has become quite familiar with the fluctuating geography of the area he studies: Shorelines migrate continuously, lakes and islands regularly appear and disappear.

The Amazon River drastically changes the volume of its flow through the course of each year. During the rainy season in the Amazon basin, the river's water level can rise as much as 50 feet from where it sits in the dry season. As a result, hundreds of hectares of the rainforest on its banks spend eight to 10 months of the year partially underwater. This especially fertile flood plain is a significant contributor to the ecology of the Amazon: It makes up approximately seven percent of the entire basin.

For "whitewater" rivers like the Solimoes, which owes its light color to the nutrient-rich sediments churned up by turbulent, fast-flowing watershed tributaries from the Andes, the flood plain is known as varzea, which means "cultivated field" in Portuguese. A high tannin content and gentler tributaries give "blackwater" rivers such as the Rio Negro a somber tone; their flood-plain zone is commonly called igapo.

At Manaus, in the central Amazon, the flood peak follows the rainy season by four to six weeks, and the river usually reaches its lowest point in November. In between, the water level is always either rising or falling—the river's banks rarely remain at the same level for very long. For the people we passed on the island, this requires some major adjustments in lifestyle. Many families build their houses on stilts to accommodate the rising waters; because those we saw were keeping oxen, they will have to move to firmer ground while the river is at its highest.

Human inhabitants of the flood plain are not the only ones whose behavior is dictated by the river's movements. Among the native creatures and plants that have adapted in many ways—physiologically and behaviorally—are the abundant aquatic grasses, thousands of fish species, and even termites. And these are but a few of the untold numbers of organisms that take advantage of the regular, slow flood pulse of the Amazon.

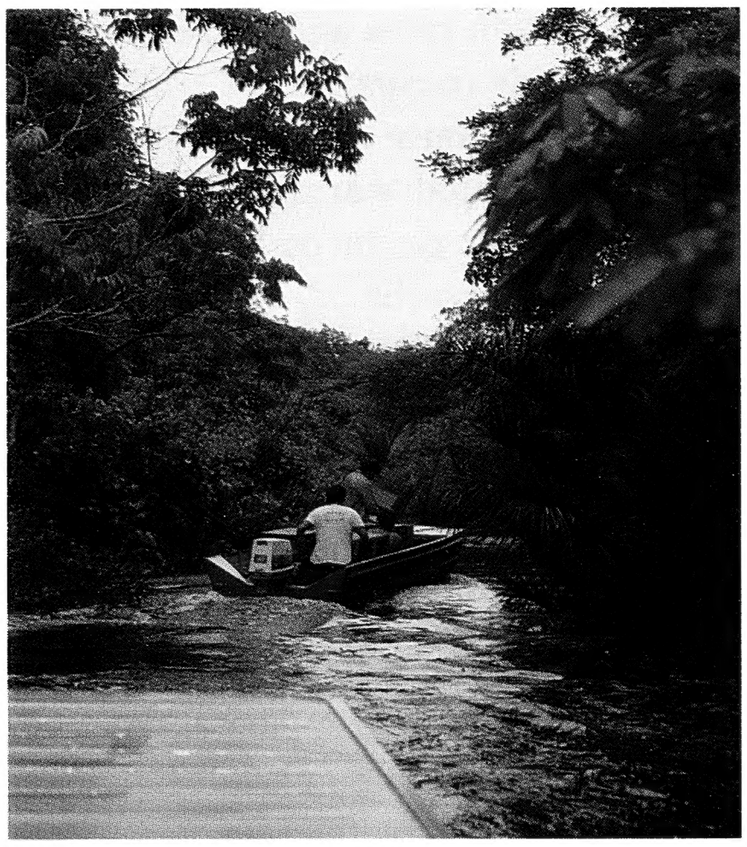
The ceaseless movement of the river edge and the migrating boundaries of inland lakes prevent the permanent stagnation of bodies of water. This allows rapid recycling of organic matter and nutrients, and greater productivity than would be the case if the area were either permanently inundated or dry. The special environment created by this process sustains some of the greatest turnover in plant production in the world.

Maria Theresa Piedade ("Maite"), a scientist at Brazil's National Institute for Research in the Amazon (INPA), studies several species of fast-growing grasses in the varzea. Her research was originally part of a project sponsored by the United Nations Environment Program (UNEP), in which the same types of plants would be studied in five different tropical countries, using the same methodology, to gather data on growth rates and corresponding carbon-dioxide consumption. Carbon dioxide is a "greenhouse gas," which can contribute to global warming; the more biomass a plant produces, the more carbon dioxide it absorbs.

Though still affiliated with the program, Maite has focused on the species of grasses that, because of their abundance, are important to the varzea ecosystem and also hold potential economic significance for the natives of the area. Last year she spent 200 days, from sunup until dark, sitting in a canoe and clamping an infrared gas analyzer on a grass blade every hour on the hour. This method for measuring photosynthesis requires strong sunlight; Maite's payoff for sweating out those 100-plus degree days is her compilation of the grasses' daily and yearly cycles in carbon-dioxide absorption.

Some of these plants can grow more than six inches in one day, stretching up to 50 feet tall as the water rises over the course of the flood season. All the while, they remain anchored on the bottom in nutrient-filled water. For some species, this great productivity outstrips the al-

Varzea dwellings are built on stilts to accommodate fluctuating water levels in the flood plain. *(Photo by Carlos Miller, Conservation International.)*



Research expedition in the flooded forest. *(Photo by John A. Adams.)*

ready high productivity of the rest of the forest by some 400 percent.

This also means that these grasses account for a huge carbon-dioxide uptake. While analyzing the carbon-dioxide absorption rate of the grass species *Echinochloa polystachya*, Maite found that, in an area of 2,000 square miles, the plants can consume an incredible 75 million tons of carbon dioxide per year. Though scientists don't know how much of the varzea is covered by these grasses, their great productivity expands the amount of carbon dioxide they absorb relative to the dryland forest. In a final calculation, she estimated that the rapid-growing varzea grasses could potentially account for 25 percent of the carbon-dioxide uptake of the whole Amazon basin.

Unfortunately, colonizers often cut the grass during the dry season to clear for farming and for use as feed for livestock. This loss of grass means that a certain amount of carbon dioxide that was formerly absorbed remains in the atmosphere.

In the canoe, we speed toward a whole field of *E. polystachya*, heading for what looks like a solid bank of the head-high grass. Our guide knows that the plants are actually growing in several feet of water; the solid-looking mass is nothing more than a passageway. We race blindly through the thick stems for about 10 seconds. Suddenly we burst out upon a good-sized body of water—one of the inland lakes that form with the flood.

Underneath us, the lake is stratified sharply into different levels of oxygen content. Near the surface, the oxygen level fluctuates daily; it rises during the daytime, thanks to the photosynthesis of aquatic plants, and plunges to very low concentrations at night. The grasses that have been so quickly buried decompose and deplete the water's lower levels of dissolved oxygen. As a result, many Amazonian flood-plain trees show distinct annual growth rings, unlike a lot of the trees in the terra firma rainforest; the inundation causes a "physiological winter" through oxygen stress.

This evidence of a pronounced seasonality in an otherwise unseasonal environment is reinforced by other plants in the varzea. Most of the plants in the rest of the rainforest flower and produce fruits and seeds in continuous cycles throughout the year—they can always rely on monkeys, insects, and other herbivores to disperse their seeds and so guarantee their renewal. But because the rising waters cut many flood-plain plants off from these land-based animals, they time their seed production with the flood, for dispersal by water or by fish.

Ulrich Saint-Paul, a scientist from the Max Planck Institute in Hamburg, has been studying the interaction of the fish with the plants and trees in the varzea to help determine what might happen to the fish population if the flooded forest were cleared. Though many of the native fish are remarkably adaptable, no one knows whether they would be able to adjust to such an extreme change in their environment. Indeed, it is difficult to predict the effect on a fish population as diverse as this: So far, Saint-Paul has found more than 100 different species of fish in just one small flood-plain lake outside Manaus.

Saint-Paul describes how the fish do not simply aid dispersal of flood-plain flora; they need the fruits of these plants and trees to survive. When the water rises and the fish migrate into the forest, they feed on the fruit that falls into the water. These fish are specially adapted to consume this fruit, he says.

For example, the tambaqui (*Colossoma macropomum*), a very tasty commercial fish for the people of the Amazon, eats about 20 different fruits throughout the flood season. Upon reaching adulthood, after the first spawning, the tambaqui depends on fruit for 100 percent of its diet. For the two to three months that the fish are spawning, the forest is without water. "Some investigations show that during this period the fish are feeding on nothing," says Saint-Paul. He believes that the tambaqui lives off accumulated fat during this time.

Fish fry and fingerlings also use the varzea lakes and forest for food and shelter, feeding on zooplankton (tiny aquatic invertebrates) in the water, as well as on some kinds of fruit. They use the river primarily as a migration channel from lake to lake. According to Saint-Paul, after a season in the inundated forest, the fish leave the flood plain and migrate into the river for spawning as the water level falls. They return to the flood plain only when the river starts rising again, he says.

Varzea fish have developed some unique

Village in the flood plain. *(Photo by Carlos Miller, Conservation International.)*

adaptations to deal with the extremely low nighttime oxygen concentrations in the waters of the flood plain. Some species change physically over the space of a few hours: The skin on the lower jaw of the tambaqui and the matrincha (*Brycon melanopterum*, another important food fish) expands to form an oversized "lip." The fish skim the surface of the water with this lip, mixing air with the relatively oxygen-rich surface layer of the water, and pass this over their gills. These fish must spend a good part of the night out in the open water in order to have access to the air. As the sun comes up and photosynthesis resumes, the oxygen level rises in the water, the lip shrinks to normal size, and the fish can retreat into the protective grasses.

As we reach the edge of the lake, we maneuver around large tree trunks jutting out of the water and stop on a small bit of land not yet completely covered by the flood. This is, after all, a research outing—Chris Martius is here to keep an eye on his termites.

When he decided to come to South America, Chris found that the only opening in the Max Planck Institute's program was for a termite specialist. Though he knew little about the insects, he did have a biology background and he figured the termite work might lead to other projects. Five years and a doctorate later, Chris is an authority on termites in the Amazon. At the moment, he is the only person studying the insects in the entire basin. (By the way, Chris doesn't believe speculations that the relatively large amounts of methane created in the termites' stomachs contribute significantly to the greenhouse effect.)

He has focused his research on several species of these soil-enriching humus-feeders in the varzea, hoping to learn more about how they enrich the soil, how fast they decompose soil, and their overall role in the ecology of the area.

The termites live in the earth during the dry season and migrate into the trees during the flood, building their nests higher and higher as the water rises. It has been about three weeks since he last measured the nests in this area; as he rolls up his pant legs and wades into the water to gauge the height of one nest, he finds that the termites have abandoned their old, decaying nest and built a new one six-and-a-half feet higher up the tree in response to the rising waters.

The flooded forest near Manaus, Brazil. *(Photo by John A. Adams.)*

This site wasn't the first that Chris picked for termite study. On our way upriver, he showed us the abandoned shack of a settler who had claimed and cleared the island the scientists had originally chosen, cutting down the termites' trees after the team had completed 10 months of research. In the Amazon, science is often stymied in this way.

Leaving the termites, we make a "tourist stop" within the flooded forest. We glide under the canopy and cut the engine. Chris points out the high-water mark on the tree trunks; it's still about 10 feet above our heads. Absent are the swarms of mosquitoes that often accompany varzea researchers—whitewater rivers tend to harbor mosquitoes more than blackwater rivers, but the insects have a fortunate aptitude for disappearing when the water rises.

Here in the serenity of the flooded glade, it's hard to imagine that, while all these organisms—grasses, fish, termites—live in harmony with the natural flood pulse of the river, most human inhabitants of the Amazon continue their resolute and environmentally damaging struggle to overcome it. ✤

Pat Janowski, a freelance science writer, spent five weeks in South America last year.

Lessons from a Javanese Garden

Chris Wemmer

The seed of a new idea often has a remote beginning. This is the story of how a Zoo Biology Training Course developed at the National Zoo. The seed of that idea, born in Java, had lapsed in my memory until a few months ago, when I returned to the island after a long absence. I want to share those memories with you, and tell you where they led me . . . .

Twelve years have passed since that sultry afternoon when I found myself before an array of Javanese faces in a musty room at the Kebun Binatang Ragunan, otherwise known as the Jakarta Zoo. My friend and traveling companion Jack West, the general curator, had asked me to lecture to his animal management staff about zoos in the United States. I owed him the favor, but I thought the task was hopeless. I harbored the belief that we had little in common professionally: I was an authentic biologist with advanced degrees. Furthermore, my audience didn't understand English, and I wasn't exactly fluent in Bahasa.

As Jack tried to induce the projector to work, I mused that in 10 minutes the combined effects of my lecture, their full stomachs, and the embracing warmth of that little room would put everyone to sleep. But my expectations were wrong. The curators, assistants, and biologists listened carefully, asked some good questions, and I was surprised to find that a couple of the fellows knew their mammals well.

Their sincerity about their work made me feel a certain kinship—and a little guilt for underestimating them. In spite of the difference in our educations, I found that we shared an interest in wildlife as well as a responsibility for the welfare of our zoological collections.

I stayed with the West family in their zoo bungalow and, in the wee hours of the morning before the crickets stopped calling, I was awakened by honking hornbills and a splendid chorus of gibbons. Occasionally the ruckus was enriched by the contributions of a tokay gecko and a few dog-faced bats that lived under the bungalow's eaves, so even in Jakarta in the tepid darkness of early morning I could imagine myself in a forest in Borneo. Then the sounds of the sweepers and keepers would remind me that I was in a zoo.

The songsters that awakened me lived beside the bungalow; with them was a ragtag collection of cockatoos, mongooses, and a clouded leopard cub, all consigned to crates and makeshift cages. I was fascinated by this first encounter with hornbills; some were enormous, and all were engaging clowns that would seize the cage wire in their gargantuan beaks and gaze up at me waiting to be scratched on the head. They were hand-raised and, of course, imprinted on people: They perceived people rather than hornbills as their own kind.

There were also a few wild-caught birds. I recall one in particular, a despondent cockatoo self-plucked beyond recognition, who seemed to live in perpetual terror of life itself. No amount of cooing or

temptation by the "scratching finger"—to which almost every cockatoo will yield—could release the bird from its psychosis. The animals were well fed and the cages, though jalopies, were clean. But it was the kind of situation that makes people who don't know the animals' histories hate zoos.

"How can you put up with this? Why do you let this happen?" I suppose these were more accusations than questions.

"If you stay here long enough, you'll begin to accept a lot of things," was Jack's response.

Like a lot of people, I didn't know that most zoos in the developing world are plagued with the problem of derelict wildlife, brought about by deforestation and the trade in wild animal pets. Much of Indonesia still teems with wildlife, and, while most perishes as the forest is felled, some animals find their way into human hands. The survivors are often bequeathed to zoos by disillusioned pet owners, but, having become dependent on people, many of these animals have abnormal social cravings and are misfits among their own kind. Like orphans who reject all parental substitutes, they often end up living alone in small cages.

Confiscated wildlife is the other source of derelict animals found in developing-country zoos. I remember arriving at the Jakarta airport after a research trip to the Celebes (now called Sulawesi). Jack and I spied a crate of tightly packed coconut crabs being off-loaded with our baggage, and he confided "They will be in the zoo tomorrow . . . coconut crabs are protected and the owners won't have permits." The next day the zoo was called to come and get the contraband crabs and a palm civet (a medium-sized carnivore).

Zoos in the tropics are under enormous pressure from their governments and the public to accept wild animals. Someone has to take them, and the public and the bureaucrats have nowhere else to turn. There is no other alternative. It doesn't matter that there aren't adequate cages; most of these countries lack caging standards for wild animals, and animal welfare groups are practically unheard of.

I didn't go to Indonesia in 1978 to study its zoos; I was there to investigate wildlife in nature, in particular the little-known brown civet found only in Sulawesi. In retrospect, my travels prepared me better to understand the Jakarta Zoo within an institutional context than to understand the brown civet in its ecological context.

John Seidensticker

"As developing-country zoos go, Jakarta was in a class of its own.... I learned many lessons about tropical zoos in its gardens."

Theodore H. Reed, NZP's past director, arranged for my entree to Indonesia through his friend and colleague, Benjamin Galstaun, the late director of the Jakarta Zoo. Galstaun treated me like an old friend, and over a three-year period, I visited Indonesia for one or two months and used the Jakarta Zoo as a base of operations. As developing-country zoos go, Jakarta was in a class of its own, with splendid landscaping and commendable exhibits. I learned many lessons about tropical zoos in its gardens.

Galstaun was a fascinating and lovable raconteur, who seemed to conduct most of his business from his house, which was hidden by a tropical garden in the heart of the zoo. Born to an Armenian father and a Javanese mother, he was raised on a farm in eastern Java and educated in Dutch schools. He spoke five languages fluently, and was an unrelenting critic of animal dealers, corruption, and most politicians. He suffered fools poorly, and his most endearing characteristic was a knack for producing outrageous remarks at unexpected moments. He was a master of timing. Galstaun's traits endeared him to his employees and made him the bane of his targets.

The zoo was a happy little community, from the widows who swept it clean every morning to an odd assortment of expatriates, biologists, and zoo personnel who visited the Galstaun house regularly just to bask in the director's aura and receive his zoological advice. Next to his house was a small visitor's bungalow that was open to any earnest biologist.

Galstaun and his wife Henrietta created the zoo from an old

fruit orchard in the 1960s without benefit of architects and engineers. He visualized the layout of exhibits and whole sections, produced watercolor sketches as good as those produced by any commercial firm, and then pegged out the area. When the laborers arrived on the appointed morning he was there to supervise their work. The construction was often done in record time. NZP curator of mammals John Seidensticker, a devotee of Galstaun, once told me he had witnessed the construction of a pond and island habitat in just a few days with Galstaun the foreman donning a straw hat. My opinions of developing-country zoos were challenged by the achievements of Galstaun's zoo.

It took a good many more trips to Southeast Asia and its zoos before I realized that the Jakarta Zoo was exceptional. It owed its distinction to the fact that one man had dedicated nearly two decades to its creation and refinement. This, unfortunately, is no longer the case, as the directorship of the Jakarta Zoo is a political appointment that now changes with each gubernatorial election. This is the prevailing pattern in less-affluent countries, and it accounts for the fact that many such zoos are disappointments at best.

Six years after my last trip to Indonesia I decided to try to help zoos in less-affluent nations by designing a training course for mid-level managers, namely the curators, technicians, and veterinarians who are the permanent employees responsible for animal management. With a seed grant from the Smithsonian Institution, veterinarian Andy Teare and ornithologist Charles Pickett helped me design the curriculum.

The three of us went to Bangkok's Khao Kheow Zoo in 1987 to present our first course to a class of 20 that included directors, curators, veterinarians, biotechnicians, and lead keepers, as well as a few supervisors of the Royal Forest Department's Wildlife Breeding Centers. The experience was a kind of cold-water baptism that awakened us to zoo needs in the far corners of the world.

"The Jakarta Zoo owed its distinction to Benjamin Galstaun, who dedicated nearly two decades to its creation and refinement."

John Seidensticker

We wanted the course to be a smashing success, and fancied ourselves as sufficiently engaging lecturers to impose a marathon schedule upon our well-mannered class—no days off for the course's three-week duration. We taught in an outdoor lecture hall, assisted by two or three translators. Even so, the language barrier forced us all to simplify our lectures to the bare essentials, often repeated for emphasis with subtle variations.

"Hornbills need many perch. If not enough perch, big problem. Dominant hornbill attack number 3 hornbill. Number 3 hornbill unhappy. Not good!"

It seemed to work, and though we could only incite discussion in the Anglophone quarter of the class, we never caught anyone nodding off during lectures.

Like good missionaries we had our own agenda, and one of our cherished goals was to inspire these foreign colleagues to undertake cooperative breeding programs for endangered species native to Thailand. While Thailand is a jewel of economic development in Southeast Asia, her wilderness has been gravely compromised by cultivation.

Much of Thailand's unique fauna is now endangered, but every zoo had a number of exciting zoological treats: pileated gibbons, Fea's muntjacs, great hornbills. However, only a few animals were marked with eartags, tattoos, or leg bands to make them identifiable as individuals, which is a basic requirement for scientific animal management. Virtually the entire animal collection was anonymous. The exceptions were a handful of specimens that had achieved distinction by virtue of being the only representatives of their kind in the collection. Broken horns, twisted tails, and scars distinguished a few others, and finally there were those that had become celebrities through behavioral fixations such as chronic masturbation or heroic criminal infractions against keepers.

Persuading the class to mark animals was a ponderous undertaking. We were told that there were strong public, aesthetic, and sometimes administrative objections to seeing marked animals in

the zoo, and somehow the word "mutilation" was introduced by the defense. If the public saw the Eld's deer sporting orange eartags, we were told, they might march to the director's office and demand removal of the offending contrivances. Or they might take their grievance to the newspaper, or worse yet, to the zoo board, which was composed of generals and businessmen.

We were given to believe that eartags were so distasteful that their presence on animals could precipitate dire personnel actions and financial consequences. This posed something of a problem, because we placed great faith in eartags, and our whole philosophy was predicated on reliable individual recognition of animals. What's more, a sizable portion of our course hinged on marking all the specimens of one or two species in the collection so we could demonstrate the compilation of a record book.

Imperfect translation left both sides of this friendly debate in some doubt as to the opponents' exact message, but this uncertainty could also be played to advantage. Like undaunted traveling salesmen, we smiled as we opened our supply trunk and produced strings of aluminum and colored bird bands looking like trade beads, brightly colored eartags with bold numbers, wing tags, nasal saddles, neck and web bands, and the applicators for their attachment. From the way the class eyed this merchandise we judged the ploy a success.

It was time for a demonstration; at least we could show that it wasn't difficult to band a bird or to eartag a fawn. Afterwards, when we trudged sweating back into the lecture hall, there was a line of requests for the supplies, and we ended up giving them all away. We had our doubts that the supplies would be used, but Andy Teare visited the Khao Kheow Zoo just a few months ago and reported that all the Eld's deer were now eartagged. This small but significant achievement hasn't yet alienated the visiting public.

We harbored the naive expectation that our lessons would be embraced with open arms, and so we weren't prepared for resistance. We began to realize that though many standard zoo practices of affluent countries are carried out in the developing world, they are not reinforced within the organization. They are done as an end in themselves, rather than as a means to an end. Many of the more than 60 zoos now represented in our classes have animal record systems, for example, but on close examination most of them have proven to be incomplete and inconsistent. One of the reasons is that no one has responsibility for records.

John Seidensticker

"Like a lot of people, I didn't know that most zoos in the developing world are plagued with the problem of derelict wildlife, brought about by deforestation and wildlife trade."

Keepers are the unsung heroes of zoos everywhere. In the developing world, keepers are usually illiterate males, often dispossessed villagers who have come to the city in search of employment. There are keepers in some zoos that are homeless. Exploring a Thai zoo early one morning, I found a keeper sleeping soundly on top of a crate under a little shed roof—protected from rain, but not mosquitoes. But, in almost every zoo, we have encountered dedicated keepers whose main reward is the personal satisfaction of working with animals.

Andy encountered such a keeper in Jakarta when he organized a class project to screen for kidney stones in a group of small-clawed otters. The fellow, who was young but toothless, listened attentively to the translated instructions: The otters had to be caught one by one without stress. Few zoos in the tropics have adequate holding and capture facilities, and animal restraint often proves a spectacle that demands the timing and coordination of professional stunt men.

Andy was prepared for the worst, but when the keeper climbed through the small opening into the pen, he was suddenly surrounded like Saint Francis by a mob of friendly whimpering creatures. These little squabblers lived within earshot of our bungalow, and normally they swam back and forth and made irritating noises. But, transformed by the keeper's presence, several could be picked up like puppies and injected with the tranquilizer. Each one had a name, evidently known only to the keeper, for there were no written records on these creatures in the zoo. He knew the year of the

arrival or birth of each animal; he knew their societal and familial relations completely.

The talents of such keepers are sometimes unrecognized by their supervisors. For several courses now, we have attempted to locate talented and outgoing keepers to train as "interpre-keepers." The purpose of the exercise is to demonstrate that nonaffluent zoos can use existing staff to inform the public and answer questions. In Guatemala, a suave young keeper named Erwin volunteered for the first exercise, and spider monkeys and pacas were selected as the species of choice. When the project team was satisfied with the script they had prepared, it was handed over to Erwin for memorization. We smiled at his confidence as he sashayed before the class during his dress rehearsal in front of the spider monkeys.

"Buenos dias. My name is Erwin and I work here in the Aurora Zoo. I am in charge of the care of the spider monkeys. I clean their homes and I feed them. We give them beans, lettuce, bananas, and papaya . . . ." The guy was a born actor, and the live performance was delivered with a flare that only Latins can master.

The commencement ceremony that marks the end of each course took place in a restaurant in Guatemala City, and sitting across from me with a mug of beer was Erwin. With a furrowed brow he asked, "Dr. Chris, do you really think I did a good job?" Here was a chance to use a Spanish phrase I know in several tenses. "Mi amigo, estuvistes fantastico." Experiences like this convince me that many improvements are possible at small costs.

Zoos around the world have great, but largely unrealized, potential to contribute to wildlife conservation. There are many zoos in the developing world, and most of them need help. Nearly 100 million visitors annually attend the zoos that have been represented in the six training courses we have held so far.

While there are many obstacles to improvement, I can't agree with the assertions of some nongovernmental organizations that zoos have little to contribute to wildlife conservation. Ironically, this view is even reflected in developed countries, where affluent zoos usually turn a blind eye to their sister institutions in developing nations. The reason is obvious: Most affluent zoos aren't convinced that tropical zoos can make a difference, and don't care to be associated with the horrors that often characterize these institutions.

"I was fascinated by this first encounter with hornbills; some were enormous, and all were engaging clowns."

Alain Compost

But as the forests burn, zoological riches continue to pass into these institutions, where in due course they perish without issue, nothing gained and nothing learned. In my view, it is a crime and a waste of great potential. With concerted effort and funds, at least the better tropical zoos could be brought up to standard and their treasures used to educate people and increase biological knowledge. Much can be learned from these animals for whom captivity is the final chapter.

There's another compelling reason. Far more people visit zoos in developing countries than are affected by the many other organizations concerned with public education and environmental issues. The long-term human benefits of conserving wildlands are unappreciated by the masses of those countries whose biological diversity is most threatened.

We know that foreign tourists are often the primary users of national parks and wildlife sanctuaries, and that only a fraction of indigenous people have the time, money, or concern to visit such areas. We also know that most zoo visitors don't seek knowledge during their outings. But a comprehensive educational strategy for zoos could go a long way toward influencing public attitudes about nature.

With their millions of visitors, zoos can play a major role in shaping public attitudes about wildlife and the wilderness needed for its continued existence. There is a small but growing group of North American zoo biologists who are working for this change and, for my own part, it all started in a Javanese garden. ✤

Chris Wemmer is the National Zoo's associate director for conservation.

Monarchs, Mimicry & Misinformation

Text and illustrations by Sriyanie Miththapala

"I tawt I taw a puddy tat!" says Tweety Bird and, for the umpteenth time, flies safely away from the greedy, grabbing claws of Sylvester the Cat. Wile E. Coyote invents elaborate devices to catch the Road Runner, who always manages to escape.

In nature, prey species—those animals that are food for other animals—have evolved several methods to avoid being eaten by predators. An all too familiar example is the painful bite or sting from an ant or bee, which teaches most predators to keep away.

Some prey species emit secretions that are poisonous or that just taste awful. The lesson that a predator learns from eating such prey is simply not to eat it again. In this case, it is also good for the prey to give a signal that the predator can see in addition to taste, that says "I taste bad, don't eat me." Prey species that taste obnoxious are often colored and patterned distinctly—bright red, orange, or yellow, with bold black stripes, bands, or spots. This type of warning coloration is called **aposematic coloring** (*apo* meaning away and *sematic* meaning signal).

True or False?

Aposematic coloring is a true signal. But some animals lie! They have evolved a set of false signals to portray themselves as harmful, when in fact, they are not. In nature, this kind of "lying" is called **mimicry**.

Mimicry is like a play in which there are three actors: the **model**, which is harmful, perhaps producing poison that can hurt a predator, and also having aposematic coloring; the **mimic**, which is a look-alike of the model, but is not poisonous; and finally the **dupe**, the predator that can't tell one from the other. This "play" has been staged many times in the animal kingdom, and its most famous actors are probably the monarch and viceroy butterflies.

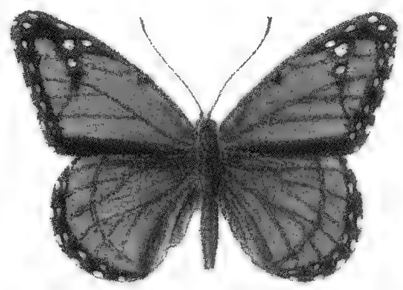
Bates and the Butterflies

Henry Bates, a nineteenth-century naturalist traveling in the Amazon rainforest, first described mimicry of monarch butterflies (*Danaus plexippus*). Adult monarchs are orange with black markings. The caterpillars of these butterflies feed on milkweed plants, which have toxins in them. The caterpillars are unaffected by these toxins, store them in their bodies, and retain them as adult butterflies. When a bird feeds on an adult monarch, the butterfly's stored toxins are potent enough to make the bird throw up immediately. Naturally, the bird learns very quickly not to eat orange butterflies with distinctive black markings.

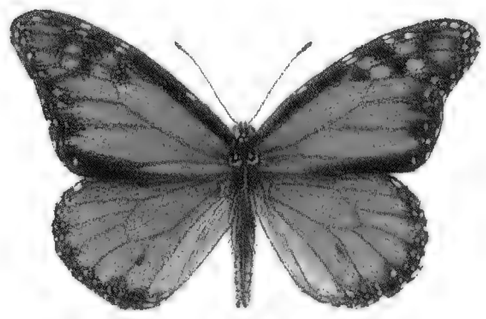
A number of butterfly species that do not store toxins have evolved aposematic coloring and look very much like monarchs, thus avoiding predators who mistake them for their foul-tasting counterparts. The best-known mimic of the monarch is the viceroy (*Limenitis archippus*). This kind of mimicry is now called Batesian mimicry after Henry Bates.

Another example of Batesian mimicry has been observed in snakes. The harmless false coral snake (*Lampropeltis elapsoides*) mimics the colors and banding patterns of the highly venomous coral snake (*Micrurus fulvius*).

(Continued on page 18.)



Viceroy
The Mimic



Monarch
The Model

Find the Hidden Animal

In nature, prey and predator alike have evolved many ingenious methods to disguise themselves from their would-be attackers and victims. In this activity, **model, mimic,** and **dupe** have cooperated in building two lines of defense to remain hidden from you. The first step in exposing these 10 animals is to identify them correctly using the clues they have provided. Second, you must locate their names in the field of letters in which they are hiding. Some of them are well-camouflaged—don't let them make a dupe of you!

1. Like the large cats that died out during the Pleistocene, I am described as "saber-toothed."

— — — — — — —

2. One member of my family was so full of toxins that he caused eight different blue jays to throw up! I may taste terrible, but I sure am pretty!

— — — — — — — —

3. My relatives include the cobras, and highly potent venom runs in our family.

— — — — — — — — — — —

4. Though I'm identified as "American," I spend a considerable amount of time in Canada, too. My distinctive call has earned me the nicknames "Thunder-pumper" and "Stake-driver."

— — — — — — — —

5. I am small, have very powerful venom, and am extraordinarily bad-tempered. This, along with the fact that I like to lie buried in the sand, has earned me a reputation in some circles as "the world's most dangerous snake." By the way, I live in Asia as well as in Africa.

— — — — — — — — — — —

6. My name implies that I have a lower rank than the animal I mimic. But I assure you that we're much less common than they are, and the birds would find us more palatable, too.

— — — — — — — —

7. Some species in my family have brown and green color forms, so they can choose the appropriate background vegetation on which to sit. With that kind of adaptability, none dare call us "sticks in the mud."

— — — — — — — — — — — — —

8. Hey, I'm good at what I do—my customers are satisfied with my cleaning services. Now if I could only get my fins on that toothy little guy who's been trying to damage my reputation!

— — — — — — — — — — — — —

9. I can barely swim, but what of it? I do my fishing from the seabed and I never need to visit the tackle shop.

— — — — — — — — — — —

10. My relatives can be found throughout the world and we're all part of the grasshopper family. Many of us like to hide out in trees—we just tell predators, "Please leave us alone."

— — — — — — — —

Answers: *1. blenny 2. monarch 3. coral snake 4. bittern 5. carpet viper 6. vicerоy 7. stick insects 8. cleaner wrasse 9. anglerfish 10. katydid*

Locate the answers to the previous activity in the field of letters below. Answers will run vertically, horizontally, or diagonally.

S E B O Q K U N C A R P R B A

T Y R Y U C R S O G V I U R O

A N U L D E W F R O Y N C E N

F N S I T H O X A M S L Y P A

P E K T E I V A L F E S H I Y

G L I D N R K U S A G W E V H

A B O S T C E S N I K C I T S

R N S M W I D E A L Z E V E I

M E R B O G R O K E W K U P F

H O I T L W X L E M I A L R R

C U N N R E G N N I C T N A E

O B Q A D V I C E R O Y I C L

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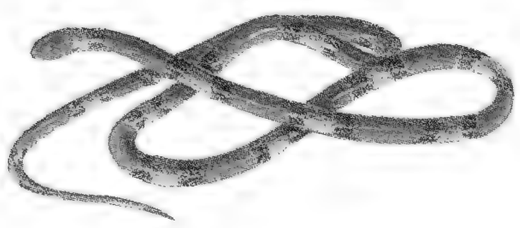
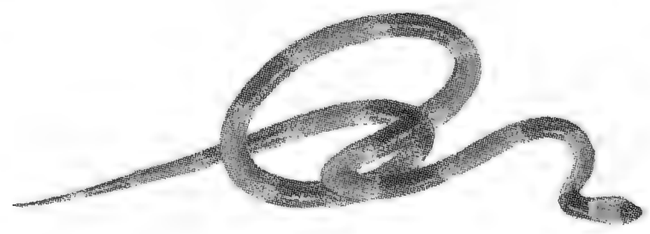


False Coral Snake
The Mimic



Eastern Coral Snake
The Model

A Fish Story

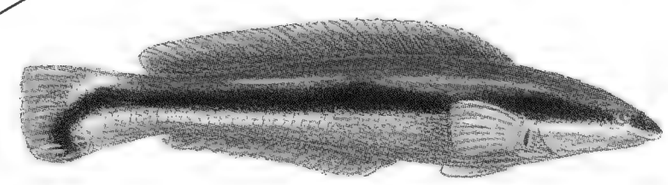
In another kind of mimicry, the model is agreeable to the dupe, but the mimic is not. For example, the cleaner wrasse (*Labroides dimidiatus*) is a small fish with distinctive markings. These fish remove ectoparasites from the bodies of larger fish, who might easily eat them, but the wrasse provide a nice cleaning service. However, the mimic saber-toothed blenny (*Aspidontus taeniatus*), disguised as a cleaner wrasse, gains access to the larger fish and, rather than removing ectoparasites, removes a chunk of flesh instead!

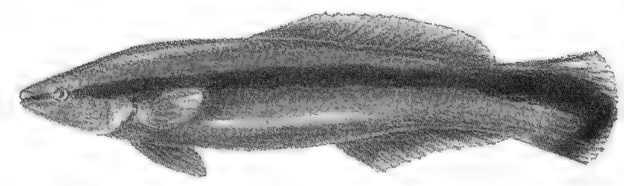
In addition to mimicking aposematic coloring, some species mimic certain behaviors of a model. The African carpet viper (*Echis carinatus*) coils itself and produces a rasping noise by rubbing parts of its body together in a warning behavioral display. This display is mimicked by harmless snakes of another genus, *Dasypelti*.

(Continued from page 15.)

Camouflage

In the previous examples, the model was harmful to the dupe. In another kind of mimicry, called **camouflage**, the dupe is indifferent to the model. The mimic evolves patterns or colors like the model's that enable it to blend with its environment and hide from predators. Katydids look like leaves; stick insects look like, you guessed it, sticks; and some caterpillars look like bird droppings. The American bittern (*Botaurus lentiginosus*) is a marsh bird that lives among reeds. When predators draw near, this bird stretches its neck (which is colored like a reed), points its beak skyward, and becomes virtually indistinguishable from the surrounding reeds.

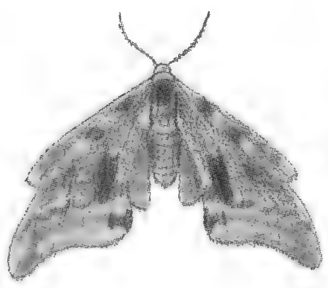




Saber-Toothed Blenny
The Mimic

Cleaner Wrasse
The Model

Eyed Hawk Moth
Eye spots exposed



Eyed Hawk Moth
Resting position

Eek!!

Yet another line of defense is to startle the predator. When cornered, some prey species resort to behaviors that can momentarily confuse the predator, allowing for a quick getaway. Certain hawk moth caterpillars respond to threats by inflating their heads and moving them quickly in a pantomime of more fearsome snakes, thus confusing predators with pure bluff. Many moths have eyelike spots on their wings, which are normally hidden from view. When a predator approaches, they suddenly expose these spots.

Sending false signals is not necessarily restricted to prey species. Some predators find devious means of attracting prey. For example, the anglerfish (*Lophius piscatorius*) has a rodlike appendage on its head that dangles a wormlike bait. The prey fish is lured by this bait and captured.

Polar Bears.
1990. Ian Stirling.
Photographs by
Dan Guravich.
The University of Michigan
Press, Ann Arbor.
220 pp. paper,
$19.95.

What makes a bear a bear? And how do you distill the essence of a bear? When I read that Ian Stirling had written a book about polar bears, my first thought was that if anyone could distill the essence of polar bears, that person was Ian Stirling. Stirling, after all, entered the world of the polar bear, which he has now studied for two decades, from the perspective of the bear's primary food source: seals. Stirling did his early work on the behavior and ecology of seals, and many facets of the behavior of arctic seals can be attributed to their attempts to avoid the great white bear. Likewise, the behavior of polar bears is tied to the life of the seal and the extreme demands that emanate from the Arctic and subarctic environment.

As I read this book I was pleasantly surprised, then pleased, then awed. Stirling exceeded my high expectations. This is a fine book, arguably the best natural history account of a mammal to appear in the last decade. *Polar Bears* stands with Barry Lopez's *Of Wolves and Men* as an example of writing natural history with a sophisticated and sensitive understanding of the animal as a coparticipant in its environment.

Polar Bears includes sections on the first polar bears, the original polar bear watchers, how to study a polar bear, distribution and abundance, reproduction, behavior, life and death, what makes a polar bear tick, the polar bears of Churchill, conflict between polar bears and humans, conservation and environmental concerns, and the future of polar bears. When I read the section "The original polar bear watchers," which explores the relationship between the other hunters who depend on the polar seas—the Inuit and other indigenous peoples—and the great white bear, I felt it could have been developed more fully. I changed my mind after reading on in the book. Stirling has spent a great deal of time working with the Inuit people during the course of his research. His admiration for their skill and for the great risks they face daily in hunting and just living in the world of the polar bear is apparent throughout. His understanding of the polar bear has been greatly enhanced by working with Inuit hunters, and his writing helps the reader experience this. His sensitive understanding of the needs of Inuit and other native Arctic peoples is also apparent in his discussion of the conservation and the future of polar bears.

In *Polar Bears,* Stirling forced me to think about the bears and seals and ice in new ways. The tension between these elements is at the core of what polar bears are about. He explains Uspenski's "Arctic Ring of Life," and his figures summarizing what is known of the distribution and abundance of polar bears in relation to major shore leads, polynyas (systems of leads and areas of open water surrounded by ice), and maternity denning habitat are bound to be widely copied. I had never contemplated the problems involved in finding and catching seals in an environment where the sound of a person walking on the ice can be clearly heard up to 1,300 feet away. How the polar bear has solved this and a host of other challenges associated with living in the Arctic is all here.

Polar Bears includes nearly 150 color photographs grouped in seven sections. Most are by Dan Guravich and a few are by Stirling. All are superb. They fully document the life history of the bear and place it in its environment. In some sections, the photographs unfold from portraits of the polar bear to a portrait of the High Arctic itself.

When the First International Meeting on the Conservation of the Polar Bear was held in 1965, there was serious concern that the polar bear was endangered. Stirling's good news is that after 25 years of intensive international effort in research and management, and through the establishment of the "International Agreement on the Conservation of Polar Bears and Their Habitat," the great white bear seems reasonably secure. But the polar bear is vulnerable to overhunting and to activities that threaten vital denning and feeding habitat. The latter are found in areas of intense international interest for on- and offshore hydrocarbon production. In identifying the future conservation agenda for polar bears, Stirling's book is a reminder to be vigilant.

—John Seidensticker
Curator of Mammals

Polar bear (Ursus maritimus). (FONZ Photo Archives.)

The Return of the Red Wolf

October 16, 1990, was a day to remember at the National Zoo. The sun shone brightly on the crowd of honored guests and Zoo employees who had gathered to witness the release of a pair of red wolves (*Canis rufus*) into their new enclosure in Beaver Valley, and to mark the National Zoo's participation in another program to reintroduce an endangered species to the wild.

After remarks by Secretary of the Smithsonian Robert McCormick Adams and Secretary of the Interior Manuel Lujan, the skittish predators were released from travel kennels into the newly renovated wolf yard to begin a life that is hoped will add many young pups to the reintroduction project. The Interior Department's U.S. Fish & Wildlife Service (USFWS), an agency that in the not-too-distant past paid bounties for red wolf hides, heads up the effort, with the cooperation of several state agencies, private organizations, and zoos throughout the country.

"Red wolves once ranged over much of the southern United States and into Mexico, roaming virgin forests from Texas to Florida and north into the Carolinas and the Ohio Valley."

The red wolf is a distinct species, cousin to the gray wolf (*Canis lupus*) and coyote (*Canis latrans*), and intermediate to the two in many aspects of appearance and behavior. Red wolves are not actually red like a fox, but gray with a tawny, rusty tinge to the coat. The face is lightly colored on the muzzle and around the eyes. The wider skull, larger nose and ears, and the ruff framing the face paint a wolflike portrait that distinguishes this animal from the foxy coyote.

William Sugg

Photo by Jay Tishindorf

Red wolves returned to the National Zoo last fall after a 45-year absence. (Photo by Jessie Cohen/NZP Graphics.)

In size, the red wolf is between the coyote and gray wolf, averaging around 55 pounds but ranging between 50 and 75 pounds. The red wolf is often as tall as the gray, but its body is less massive, giving it a leggy appearance. Ranchers, differentiating it from the coyote, referred to it as the "long-legged" or "tall" wolf.

The social structure of the red wolf is also between that of the coyote and gray wolf. Although generally a loner, the red wolf is not as solitary as the coyote, but is far less gregarious than the pack-living gray wolf. The teamwork of the pack is required to bring down the gray wolf's typically large prey; although the red wolf travels in small groups, it does not need to form such alliances in order to subdue its small prey.

Red wolves subsist primarily on a diet of small mammals—nutria, rabbits, rats, muskrats, and raccoons are staple fare. They also occasionally eat turtles, insects, frogs, fish, and even some plant material. Predation on deer occurs, but as with cattle, this usually only involves the opportunistic taking of young animals.

To "the Brink of Disaster"

Mammalogist E.A. Goldman described the three subspecies of red wolf generally recognized today: *Canis rufus floridanus*, wiped out about 1910; *Canis rufus rufus*, the Texas form, which was gone by the early 1950s; and the only surviving subspecies, *Canis rufus gregoryi*, the Mississippi Valley red wolf.

Red wolves once ranged over much of the southern United States and into Mexico, roaming virgin forests from Texas to Florida and north into the Carolinas and the Ohio Valley. This range bordered and possibly overlapped the former geographic ranges of the gray wolf to the north and the coyote to the west.

The red wolf's generic relationship to the coyote is partly to blame for the decline of the species. Coyotes and red wolves readily interbreed and produce viable hybrid offspring. Behavioral and ecological barriers had kept precolonization populations of coyotes, red wolves, and gray wolves distinct, but this natural balance was disrupted by intensive farming, grazing, and logging, as well as the predator-control programs begun in the early 1900s. These changes favored the coyote, which prefers the disturbed habitats associated with man and is more wary and, therefore, more difficult to poison, trap, or shoot than gray or red wolves.

During the first half of this century, the red wolf suffered a major decline, not only from loss of its dense forest habitat and persecution by man but also from genetic swamping by the wily and adaptable coyote. By the 1950s, the red wolf existed only as legend throughout most of its former range.

In 1915, Congress mandated that wolves were to be exterminated from all federal lands. Intensive predator-control measures were carried out at the federal, state, and local levels; anyone with guns, traps, or poison waged war on the red wolf, gray wolf, coyote, and many other predator species.

Viable populations of gray wolves managed to survive in Minnesota and Canada, but otherwise the annihilation was almost complete. More than 80,000 gray wolves were killed by the 1940s; in 1963, the 2,771 red wolves taken in Arkansas, Oklahoma, and Texas probably represented the majority of the remaining population. In 1965, the red wolf was placed on the endangered species list.

In the 1960s, as public and government sentiment about the environment was changing, scientists began a search for the remaining genetically pure red wolves. Studies conducted in 1962 by Howard McCarley of Austin College suggested that the red wolves of east Texas had been totally replaced by coyotes and red wolf/coyote hybrids.

In 1964, pioneering wolf researcher Douglas Pimlott became interested in the status of the red wolf. He and student Paul Joslin came from the University of Toronto to conduct surveys in remote areas of Arkansas, Mississippi, Louisiana, and Texas, using taped wolf howls (or human imitations) to elicit the characteristic response howl of the red wolf. Pimlott and Joslin also questioned local residents about where they had last seen, heard, or killed a wolf. Finally, they studied museum skull collections to determine the extent of hybridization of the coyote and wolf in the region.

"In 1974, the U.S. Fish & Wildlife Service began its bold project to bring the remaining red wolves into captivity, build up the population, and release the wolves in safe havens within their former range."

The results were far from encouraging. The remaining red wolves were confined to a small area of coastal Louisiana and Texas, not really protected by the relatively toothless Endangered Species Act passed in 1966. In addition, the wolves were too few in number to allow traditional population management strategies to be effective in ensuring their survival.

Pimlott concluded in 1968, "If we were to approach its preservation too deliberately, I think by the time we get going, the red wolf will be extinct....The intensity of hunting on them is very great and there is very little time for carefully pondered and developed programs of scientific research.... This is a species on the brink of disaster."

The (Long) Road to Recovery

The Endangered Species Act of 1973 provided hope and legal protection for the red wolf, requiring the implementation of a recovery plan to ensure the species' survival. This paved the way for the U.S. Fish & Wildlife Service to begin its bold project to bring the remaining red wolves into captivity, build up the population, and release the wolves in safe havens within their former range.

Between 1974 and 1979, more than 400 animals were trapped. Forty-four of these were thought to be pure red wolves, but the number was reduced to 17 after scientists had completed a series of morphological and breeding experiments. This handful of animals became the founders of the captive population begun at Point Defiance Zoo in Tacoma, Washington, a facility that specializes in canid husbandry and was interested in supporting the project. The northern location was also chosen in part for its low abundance of parasites compared to the southern swamps where the mangy, tick- and heartworm-infested founders were taken.

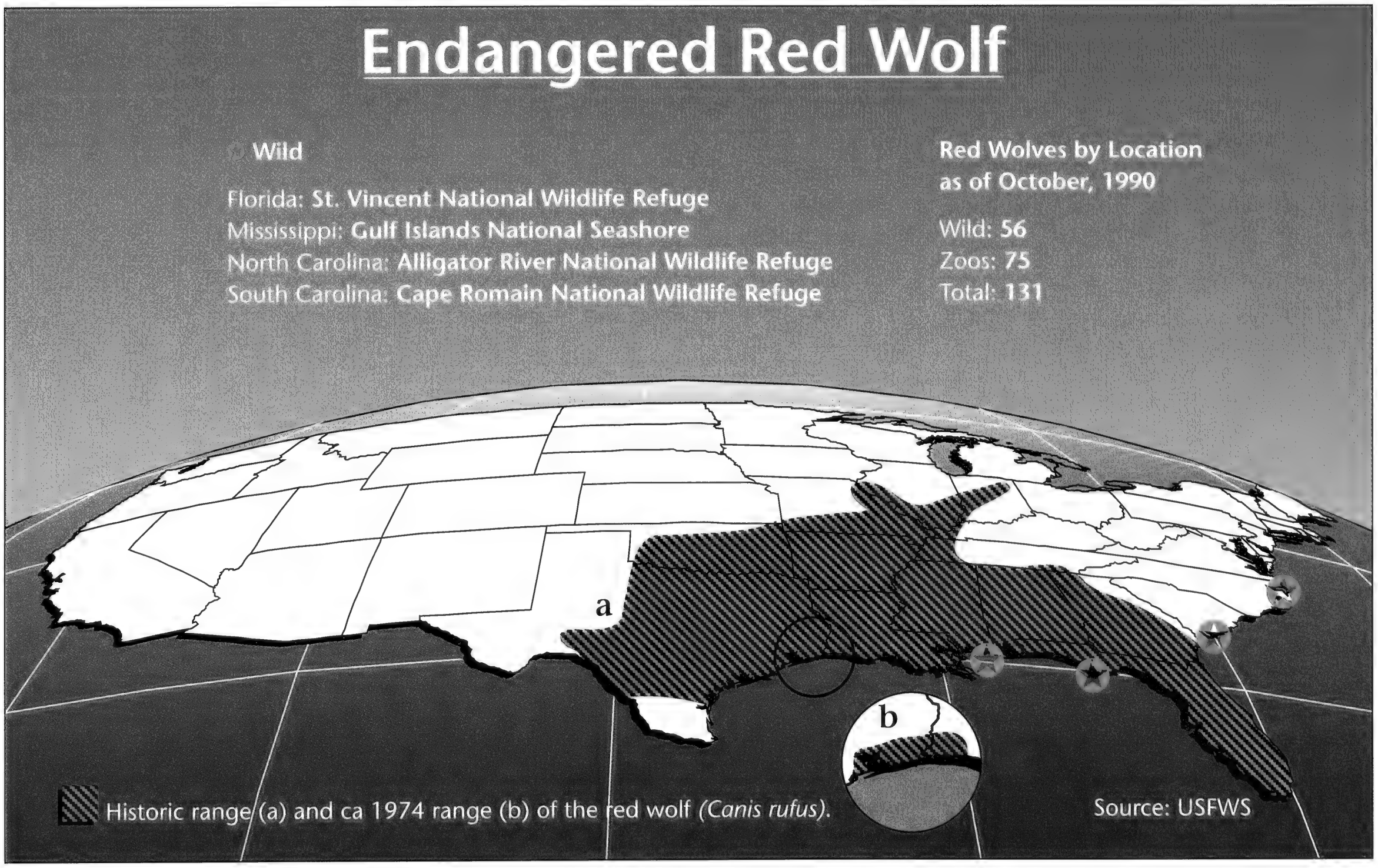
In 1977, the first litters were born at Point Defiance; by 1990, nearly 400 wolves had been born in the 19 zoos now participating in the project. Today 75 still live in captivity and 56 are in the wild.

The USFWS carried out the first experimental releases of the wolves in 1976 and 1978 on Bulls Island, north of Charleston, South Carolina. A pair was released after a 25-day stay in a large acclimation pen on the island, but the female soon swam back to the mainland. The next pair spent a full six months in the acclimation pen before their release. These wolves survived for a year on the island before they were recaptured and returned to Point Defiance. The experiment suggested that the release technique worked.

The early 1980s was a period of planning and augmenting the captive population. Some of the breeding pairs of red wolves were sent to other zoos throughout the country to avoid losing the entire captive population to a natural catastrophe such as an epidemic or fire at Point Defiance. Sites suitable for permanent releases were also investigated. The USFWS's first choice was the Tennessee Valley Authority's Land Between the Lakes, in Kentucky and Tennessee, but there was such loud opposition from farmers and hunters that plans for release there were tabled indefinitely.

Finally, a nearly ideal site was located in the 141,000-acre Alligator River National Wildlife Refuge in coastal Dare County, North Carolina. The pristine area had just become part of the wildlife refuge system in 1984. (In a deal arranged by The Nature Conservancy, the Prudential Insurance Company had donated the land to the USFWS.) The vast, uninhabited marsh and forest land supported an abundance of small mammals and could hold a number of red wolf family groups. It was also coyote-free.

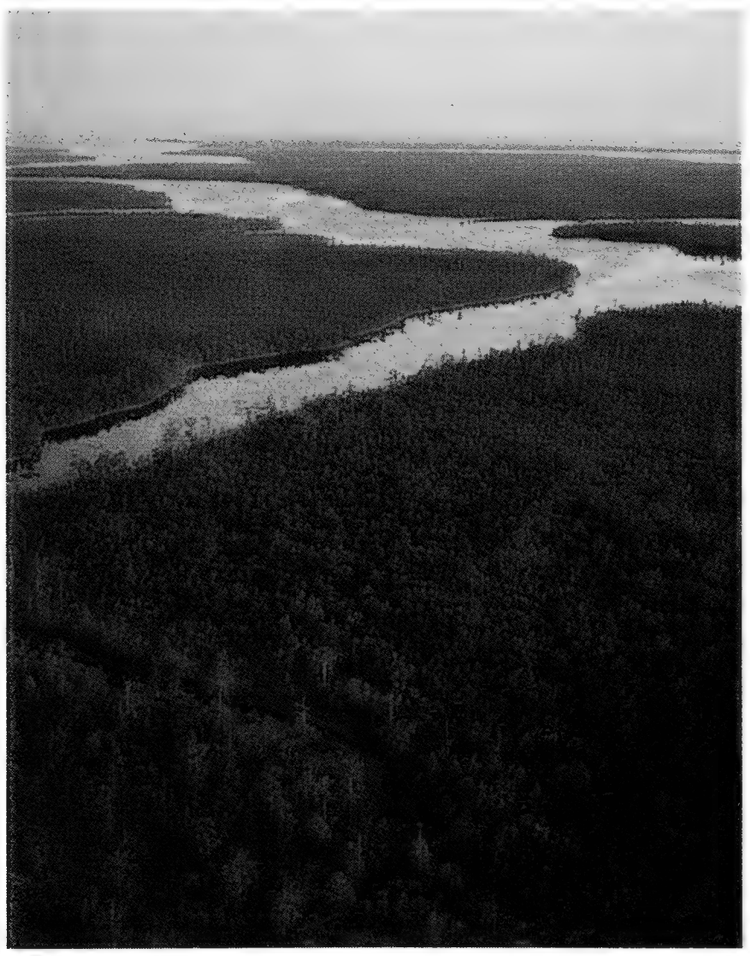
The USFWS realized early on that good



public relations would be critical to the success of the project. Warren Parker, USFWS red wolf recovery team leader, noted in the reestablishment proposal for the refuge, "The degree to which the red wolf can exist in the presence of man is almost entirely dependent on the attitude of the human population within and adjacent to the selected study area."

To allay the concerns of area residents, Parker organized three public meetings to explain the project. When people learned that their access to the land for hunting, trapping, and agriculture would not be restricted, and that the wolves would be equipped with radio collars containing remote-controlled doses of tranquilizers (developed by wolf expert Rick Chapman), they were generally amenable to the project.

The most vocal opposition came from deer hunters, who had been running their dogs in the area for generations and who believed that the government would restrict their sport in the future. But wolves had been gone a long time, if they had ever been there at all, and there was not the intense opposition that exists among western cattle and sheep ranchers to gray wolf reintroduction proposals. Also, the Alligator River population of released wolves was to be classified as "experimental/nonessential" under the Endangered Species Act, a designation that removes the threat of prosecution from anyone who accidentally kills a wolf in the pursuit of a legal activity like hunting or driving a car.



Aerial view of Alligator River National Wildlife Refuge, Dare County, North Carolina. (Photo by Ken Taylor.)

Red wolf pups are born from late March to May. Litters number from three to 12 animals, with seven being the average. (Photo by Roland Smith/Point Defiance Zoo and Aquarium.)

Return to the Wild

In November 1986, four pairs of red wolves arrived at Alligator River from the Point Defiance Zoo to begin the 10-month acclimation period in one of the four holding pens located in different areas of the refuge. Human contact with the wolves was kept to an absolute minimum. At the same time, the wolves were gradually weaned from their dry, dog-food diet to road-killed game and then to captured live prey.

In September 1987, biologists prepared the wolves for their release. The wolves had blood samples taken, then were vaccinated for distemper, parvo-virus, and rabies; they were given vitamins and heartworm preventative, fitted with the radio collars, and, finally, were released. The "soft" release technique involved simply opening the gate to the enclosure and allowing the animals to disperse at their leisure. The wolves received supplemental road-killed food after release, but analyses of their scat revealed that they were soon preying upon rabbits, rodents, raccoons, frogs, and turtles. So adept were the wolves at catching prey that some weighed more following release than at any time while in captivity!

The wolves could be readily tracked by plane, truck, or boat, using radio telemetry. Because red wolves were little-studied in the wild, there was much to learn about their behavior and movements. The wolves quickly set up territories, often using roads as traveling corridors rather than punching through the thick brush. One male, following a canal, wandered into Manns Harbor, a local fishing village, and was seen eating dog food from a bowl in someone's backyard. Warren Parker comments, "The incident actually enhanced local public interest and support for the project when the animal was trapped and returned to the refuge in an efficient manner."

"Finally, a nearly ideal site was located at the Alligator River National Wildlife Refuge. The vast, uninhabited marsh and forest land supported an abundance of small mammals. It was also coyote-free."

Within a year of their release, six of the original eight red wolves at Alligator River had died. One female died of kidney failure apparently caused by an infection, another female died of a uterine infection, and a third female had to be euthanized after she was injured in a fight with another wolf. Two males were killed by automo-

biles and a third died when he choked on a raccoon kidney (an extremely unusual occurrence).

These deaths were not unexpected by biologists. "We believe it is a measure of the program's success that all the deaths were natural or accidental and not the result of a citizen acting irresponsibly or on some unfounded hatred of the wolf," notes USFWS recovery project biologist Michael Phillips. Indeed, wolves have been caught inadvertently in traps set for furbearing animals; according to project biologists, they were in each case called by the trappers and the wolves were released unharmed.

The spring of 1988 also heralded a major success for the red wolf: the first births in the wild since the project began. Two litters of pups were born on the refuge and one pup survived from each. With much difficulty the pups were trapped, checked over, and outfitted with radio collars. They were in excellent condition, living proof that the captive-release technique was working.

Throughout 1988 and early 1989, USFWS biologists released several more red wolves on the Alligator River refuge. They also recaptured a number of wolves and temporarily placed them back in the acclimation pens to be bred. In the summer of 1989, 12 wolves were set free at Alligator River. This release included, for the first time, an entire family group, consisting of the surviving pair of wolves from 1987 and four pups born on the refuge in the holding pens. Three more pairs of wolves were also released.

The adult male from the family unit was found dead in September 1989. At seven years of age, he was considered old for a red wolf in the wild. Scientists at the USFWS's National Wildlife Health Laboratory subsequently determined that he had been killed by another wolf. This is not uncommon, as wolves tend to act aggressively toward one another until they have firmly established their territories.

This spring two litters of pups were born on the refuge, three in one litter and an unknown number of pups in the second litter. Other releases on Horn Island, Mississippi, and Bulls Island, South Carolina, have gone well.

Several new release sites were introduced last year. In the fall, Durant Island, off the coast of the Alligator River refuge, became the new home for a pair of adult red wolves and their four pups from the Ross Park Zoo in Binghamton, New York. St. Vincent Island, a barrier island off the Florida Panhandle, received two pups and an adult pair.

The Future of the Program

The USFWS is also considering the Great Smoky Mountains National Park as a site for large-scale releases. Unfortunately, the coyote is a resident of the Smokies, as it is in about 90 percent of the red wolf's historical home range.

A massive biological experiment, crucial to the success of the project, is planned to determine how red wolf and coyote populations will interact in the wild. Scientists will attempt to trap coyotes in the park and equip them with radio collars to determine their home ranges and habits. Meanwhile, several pairs of adult red wolves will be acclimating to the new area in holding pens located within the coyote study area. At the end of the acclimation period, the wolves will be fitted with transmitters, released, and their movements intensively monitored.

If assessment of the telemetry data indicates that the red wolves were able to displace the coyotes, the USFWS will develop a permanent reintroduction program for the wolves at Great Smoky Mountains National Park. If not, the red wolf reintroduction will probably be restricted to the small, island populations, which will always be dependent on man for the continued release of captive-bred wolves.

Measuring the success of such an ambitious undertaking is difficult, and probably impossible in our lifetime. The USFWS Recovery Team's long-range goal for the red wolf is a population of 500 animals—200 in the wild and 300 in captivity. After 15 years and $1.25 million, 56 wolves are living in the wild and 75 are alive in captivity.

Public misconceptions about wolves and opposition to release projects persist. Furthermore, priorities and funding commitments are always subject to change. The red wolf's canid relatives will also continue to plague the recovery. Feral dogs and the parasites and diseases they share with the wolf will always be a problem, and no one knows if even a vigorous local red wolf population will be able to maintain its genetic integrity in the face of the coyote's march eastward.

We are fortunate to live in a society that can afford the luxury of worrying about the survival of a particular animal species. Having proven our ability to destroy, we also possess the capacity to appreciate every strand in the web of life, and to realize our mistakes and strive to correct them. Endangered species restoration projects are in part our apology to Nature, from which we as a species have become so estranged. These are complex, expensive operations that we hope will form a lasting legacy so that future generations might hear the scream of a falcon, the chitter of a tamarin, or the howl of a lone wolf. ✤

Bulls Island, South Carolina, site of the first experimental releases of red wolves, retains an important breeding population today. (Photo by Phillip Jones.)

Will Sugg works in the Department of Mammalogy at the National Zoo.

New at the Zoo

Although it is too young to participate in the Olympics, the newest celebrity at the Zoo can swim circles around any gold medal winner. This new athlete is a grey seal pup (*Halichoerus grypus*), born at the National Zoo on November 16.

The first seal pup at the Zoo in several years, this creamy-white newborn attracts Zoo visitors and staff to observe its progress. Weighing 35 pounds at birth, the pup nursed on its mother's rich milk for 17 days, gaining six pounds a day. After 20 days the once small fluff weighed almost 150 pounds and was weaned. As it learns to feed on its own, the pup's weight drops and it becomes more slender. By the time the pup reaches adulthood, it will weigh between 400 and 700 pounds. This unusual growth pattern is an adaptation from its natural habitat in the North Atlantic. In the wild, the pups need to store as much energy as possible from their mother's milk before the two are separated by shifting ice.

You can come see the newest swimming sensation along with its mother, Selkie, and father, Gunnar, in the seal pool in Beaver Valley.

—Natalie J. Jordet

ZooFari 1991

Join the celebration at the biggest and best National ZooFari ever! Friends of the National Zoo has set Thursday, May 16, as the magical date for the eighth annual gala benefit. This year's wondrous event, Feline Fantasia, will highlight the beauty and wonder of cats of the world.

Enjoy a festive evening of delectable cuisine from more than 50 of Washington's finest restaurants and the special entertainment of the Drifters and Martha and the Vandellas. The festivities also include an auction, sweepstakes, dancers and entertainers, animal demonstrations, and the chance for guests to talk with world-renowned zoologists.

In the ZooFari tradition, the funds generated will help the National Zoological Park acquire, exhibit, breed, and preserve rare and endangered species. Proceeds this year will be directed toward projects that will transform the Zoo into a BioPark that displays and educates about the beauty, complexity, and interconnection of the entire living world. Included in these projects are the Zoo's new cheetah exhibit and new alcoves in the exciting Lion-Tiger exhibit.

Tickets cost $75 for FONZ members and $90 for nonmembers. A table for 10 can be purchased for $1,250. Available for $1,500 are special "Zoologist" tables, which also accommodate 10 guests. All table buyers will get reserved parking and special table service. "Zoologist" table buyers receive a private, behind-the-scenes tour of one of the animal buildings, hosted by an NZP zoologist. For more information and ticket reservations call 202-332-WILD.

All in the Family

Nestled in the rocky hillside of Beaver Valley, a family of Oriental small-clawed otters (Aonyx cinerea) will soon give Zoo visitors a unique glimpse into the home life of these smallest members of the otter family. Two litters were born last year—in March and October—to the Zoo's otter pair.

Healthy, viable populations of this chocolate-brown creature are found in Southeast Asia, India, Sri Lanka, Borneo, Palawan Island in the Philippines, and southern China. They are stouter than other otters, usually no longer than three feet in length, and weigh less than 12 pounds. Excellent swimmers they live in shallow estuaries throughout the region. Long whiskers around their snouts and on their elbows are sensitive to vibrations in the water and help them detect the location of their favorite foods, mostly snails, mussels, and crustaceans, as they navigate through the water.

Distinctive forefeet set small-clawed otters apart from other members of the otter family. Their feet are only partially webbed and have tiny, vestigial claws that grow much like fingernails. These otters are particularly agile and use their feet to probe under stones and in crevices for their food.

Small-clawed otters are not endangered or threatened, but a Species Survival Plan (SSP) does exist for them. While SSPs are usually developed for animals with very small populations in an effort to produce genetically healthy offspring, zoologists hope that by better understanding the breeding habits of the small-clawed otter, they will be able to develop model breeding plans for other, more endangered otters. While the Oriental small-clawed otter has not reproduced very well in zoos, the successful rearing of these two litters

Newborn grey seal pup displaying its photogenic qualities. (Photo by Jessie Cohen/NZP Graphics.)

will give zoologists more insight into improving the species' chances of rearing healthy offspring in zoos.

Carol Prima, keeper in Beaver Valley, has followed the saga of the Zoo's pair of Oriental small-clawed otters since November 1989. Although the Zoo has had the species in its collection since 1983, it wasn't until the current pair arrived that breeding began with any success. Prima said that the female, named Thai, is eight years old and came to the Zoo from Bangkok in April 1986. Her mate, Fu, is three years younger and arrived here from England about the same time.

Thai had already produced several offspring before these new litters. Those cubs did not survive, but a few clues surfaced that were put to work to improve the survival chances of future litters. A study showed that the cubs from earlier years' litters had succumbed to starvation. Either Thai had stopped nursing the cubs, her milk had dried up, or the cubs had not started eating enough solid food to continue healthy development. In any case, keepers were able to determine that the weaning period is critical and that they needed to watch the cubs to be sure they were making the transition to an adult diet.

Late last winter, on March 9, Thai gave birth to her first set of cubs of 1990, one male and two females. Prima noted that Thai took good care of her new litter, but as the weaning period approached, keepers noticed that only one cub was eating solid foods. The other two had never been observed eating. The cubs were taken from the exhibit for closer examination by Zoo veterinarians. The cub eating solids was twice the size of its siblings. It was pronounced healthy and sent back.

The other cubs were malnourished. The smaller of the two, a male, died the first night in the hospital, but the female responded well to hand-feeding. First, she was coaxed to lick a bit of puppy formula from a bowl, then tiny tidbits of fish were added to the formula. Soon, she was eating a normal adult diet.

At this point, Prima explained, the cub was gradually reintroduced to her family. She was placed in a holding area, where she could see and smell the other members of her family through a mesh gate. Hay from the two den areas was exchanged in order to mix up the scents. Then, her sister was cajoled into the holding den. The two animals got along perfectly and even settled down for the night, snuggling against each other. After 24 hours, the mother was enticed into the holding area and again everything went well. Finally, the male was allowed in and the family was reunited.

Then, one crisp day early last fall, Thai gave birth again. This second litter also consisted of three cubs, two of which survive. Keepers have had an exciting opportunity to see the two older female siblings participate in preparing and caring for the newborns, and to watch them learn the parenting techniques that will be put to good use in the future.

Hand-reared cub from Thai's first litter of 1990 cries out for a second helping. (Photo by Carol Prima.)

Once the parents began to build the nest, the young otters started to emulate their behavior and helped carry in the straw (which they stuff into their mouths using their paws) that keepers leave at the end of the tunnel leading from the outdoor enclosure to the nest area. By a month after the birth of the second litter, they had carried in the equivalent of two bales of hay.

On the day of the second litter's birth, the enclosure became a beehive of activity when Thai started to bring the new cubs outside to the stream (about an hour and a half after birth). Eventually, Prima said, things quieted down, and the entire family soon retreated to the privacy of the nest area, where they spent most of the next two months.

Fu has been an attentive father, making sure that all family members have eaten before he takes his turn. He also stations himself by the entrance to the tunnel or near the window, as if he is protecting Thai and the cubs, who stay at the back of the den. And, if Thai carries the cubs around the den area, he will help carry them back to the nest. The older female siblings pass their time playing and helping Fu carry fish to their mother, who has remained in the den. The older litter even helps groom the young, following their mother's example of licking and running her paws through the cubs' fur.

By mid-December, Thai again started to bring the cubs outside and began taking them into the water. The best time to see the otter family is between 1 and 3 p.m., after they have been fed and are exploring and cavorting around their stream and yard.

—Margie Gibson
NZP Staff Writer

Mother Nature's Dance

The last twitterings of the birds, punctuated by the rhythmic thunk of wood against wood, signaled the end of the tropical evening. I stepped through the door of the large palm-thatched building and let my eyes adjust to the gathering gloom within. Inside, several families huddled near the cooking fires, their faces aglow as their voices mingled with the buzzing of the cicadas. The rhythmic pounding drew my attention to the center of the room, where a man moved a stout pole up and down inside a hollow log. He was preparing the coca for the nightly vigil.

"The night is for the men," said Vicente Macuritofe Ramirez, an elder of the Murui tribe of the western Amazon (Colombia, Peru, and Brazil). "They keep watch over the people and tell their teachings until the early hours of the morning." From these teachings, the people learn how to live in the Amazon.

The men gathered in the center of the communal house as the night insects began to drone. As they passed the powdered coca and liquid tobacco, they talked casually of the day's work: how many trees they had cut, how many fish they had caught. All the faces turned as the cacique, or chief, began talking. Tonight he would tell a story of Mother Nature's Dance:

A long time ago, Mother Nature, or Royinocotai as she was called then, was concerned by the changes she saw in the world. The animals were partly human then and she wanted to find out how things were progressing with them. So Royinocotai decided to hold a dance. She invited all the animals, planning to observe their characters. Near the house, her pool's magical powers would reveal each animal's true nature. Almost all of the animals attended, and while some danced, others remained outside conversing by the magical pool.

The three-toed sloth decided to trick the tamandua (an arboreal anteater). He painted his teeth black and put some white seeds in his mouth. Then he called to the tamandua, "Look, I'm throwing my teeth into the pool—see how brave I am! Mother Nature will be so proud of me. I bet you're not so brave." With that, he spat the seeds into the water and smiled a toothless grin.

Surprised, the tamandua thought, "I can't let Mother Nature think I'm not as brave as the sloth." So he pulled out his own teeth and threw them into the water. As he watched them fall, the laughter echoed through the forest and the sloth drew closer to show his painted teeth.

The tamandua was furious. He had been tricked! His mind was filled with thoughts of sweet revenge. He wandered for a while, scheming. Then he saw a long beanlike seed pod. "Aha! An idea to trick the sloth!" He wrapped his tail around his body and tied the long pod in its place.

Later, the sloth came by to gloat about his cleverness. Smiling, the tamandua calmly ripped off his "tail" and threw it into the magical pool, completely startling the sloth. Afraid that Mother Nature would think him a coward, the sloth tore off his own tail. He threw it down into the pool where it immediately changed into a snake. As they both watched it swim away, the tamandua uncurled his real tail.

The sloth screamed in outrage, but the tamandua calmly replied, "It serves you right. Now we are even, you have nothing to complain about." And so, the sloth continues to this day without his tail and the tamandua without his teeth.

On other evenings I heard more about the dance, each edition teaching about human personalities and local animal species. The entertaining stories taught me each animal's characteristics. Other narratives described ancestors, heroic acts, and some not-so-heroic acts:

Once a group of young Murui ignored the advice of their elders. They killed and ate a stolen animal. While they were sleeping, drugged by the effect of the stolen food, the animal's owner arrived. He cast his magic net over the group and captured their eyes. The elders were spared because they had not eaten the stolen meat.

The young Murui awoke blinded and began to transform into white-lipped peccaries. The sighted elders led

Central panel of the mural at Araracuara, Amazonas, Colombia. At Mother Nature's Dance, the armadillo provides music for the main group of dancers, which includes the anhinga, the acouchi, and the porcupine.

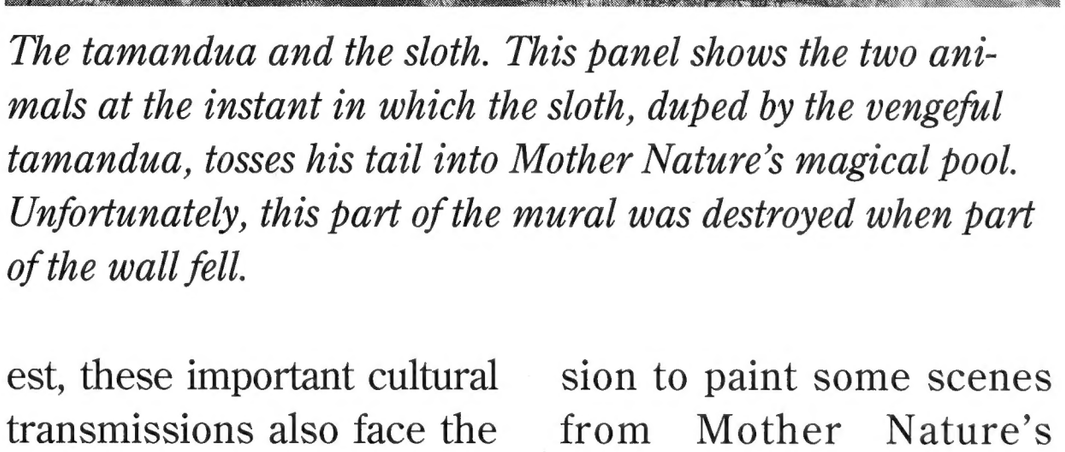
them in two lines from palm tree to palm tree in search of fruit seed to replace their eyeballs. The fruits that didn't fit were eaten by the youths. When they finally found suitable replacements, they searched for medicinal plants to clear their vision.

The story continues as the former Murui adolescents look for medicine to complete their adjustment to life as forest peccaries. In the course of their search, they find plants that provide them with fibers to form fur and medicine to clear their vision, harden their teeth, and transform their feet into hoofs.

At first glance, the story's purpose seems purely moralistic: Listen to your elders and don't take what doesn't belong to you. But the lesson goes well beyond the moral. Many of the plants consumed by the white-lipped peccaries actually do have important medicinal uses for the Murui. Furthermore, learning about the peccary helps increase hunting success. Thus, the story entertains while it teaches about the environment and necessary survival techniques.

In the past, the Murui's survival depended on their ability to verbally pass experience, techniques, and wisdom from generation to generation. Without a written language, detailed survival techniques were taught through oral history and mythology. This type of teaching, with humor and adventure, improves the learning process.

Europeans brought major changes to the Murui lifestyle. The market economy changed their view of themselves in relation to the rest of the world. Children now spend almost nine months of the year in boarding schools, learning from textbooks that make no mention of the Murui, let alone Mother Nature's Dance. They no longer spend hours listening to the stories and teachings of their fathers and grandfathers. Along with many of the plants and animals of the Amazon rainforest, these important cultural transmissions also face the threat of extinction. As a result, Murui children are learning less about the natural world that surrounds them.



The tamandua and the sloth. This panel shows the two animals at the instant in which the sloth, duped by the vengeful tamandua, tosses his tail into Mother Nature's magical pool. Unfortunately, this part of the mural was destroyed when part of the wall fell.

An enigmatic scene: This panel depicts the tapir stepping on and flattening the Amazon River turtle. According to the Murui cacique, "Thus began many of the problems in the world." That's as much as I know about this story, however, since the cacique believed the concept of the myth was too complex for a novice like me to grasp. "You're still in kindergarten," he informed me.

From 1981 to 1985, I worked for an agency doing wildlife inventories near the southern Colombia village of Araracuara, on the Caqueta River. As a scientist with a strong interest in education, I felt that these narratives should be incorporated into the educational system. Making stories like Mother Nature's Dance part of the established curriculum not only serves to legitimize them in the eyes of the school administration and the community at large, but it also means that children gain pride and knowledge as they learn about their cultural heritage and their environment.

In 1985, I received permission to paint some scenes from Mother Nature's Dance on the wall of the boarding school in Araracuara. The children's excitement with the project took tangible form as they produced wonderful drawings and stories about their favorite animal characters. Most important, I think the mural serves to remind students of the splendor of their environment and the wisdom of their ancestors.

After all, as Vicente Macuritofe Ramirez says, "The oral history is a living entity. It has a life of its own."

Wendy R. Townsend is a doctoral candidate in the Program for Studies in Tropical Conservation at the University of Florida, Gainesville. She is currently studying the hunting patterns of the Siriono Indians near Trinidad, Bolivia.

Morro Bay Kangaroo Rats Arrive

Seven Morro Bay kangaroo rats are now settled into their new home in the National Zoo's Research Building. The small mammals arrived in November from the U.S. Fish & Wildlife Service's Piedras Blancas Research Station in San Simeon, California. The Zoo is cooperating with the wildlife agency to develop a zoo breeding program for one of the most endangered small mammals in the United States.

More affectionately known as k-rats, Morro Bay kangaroo rats (*Dipodomys heermani morroensis*) live only on 200 to 700 acres of extremely fragile dune habitat in San Luis Obispo County on the southern California coast. The subspecies' range and population size, never very large, have both declined dramatically in the last 30 years. Urbanization and other human disturbances are, in part, responsible for the k-rat's decline. Ironically, however, the *absence* of one of nature's most powerful ecological disturbances—fire—has also contributed to the subspecies' problems. Regularly occurring natural fires once maintained the vegetation in k-rat habitat at early successional stages, characterized by plants such as Morro manzanita and dune almonds, whose seeds are the mainstay of the k-rat's diet. Because fires have been controlled for the last 30 years, later successional-stage vegetation has replaced the k-rat's food plants, squeezing out k-rats in the process.

In 1982, a recovery plan for the Morro Bay kangaroo rat recommended captive breeding to augment the dwindling wild populations, and in 1984 the first individuals were brought into captivity. Researchers at the California Polytechnic State University obtained several Morro Bay k-rats as well as a group of Lompoc kangaroo rats, another subspecies closely related to the Morro Bay subspecies but not endangered.

Both subspecies initially bred successfully at the university laboratory. But k-rats are notoriously difficult to breed in the lab on a sustained basis. In 1989, the surviving k-rats were transferred to Piedras Blancas, but there have been no viable births there in the last two years.

At the Zoo, William Rall and I are making a last-ditch effort to get these few remaining, and aging, animals to breed. We also plan to establish a breeding colony of the nonendangered Lompoc k-rats in an attempt to discover the secrets of kangaroo rat reproduction and, we hope, thus improve our success in breeding the endangered Morro Bay kangaroo rats.

—Miles Roberts
Department of Zoological Research

The Last Elephant

A professor of anthropology at George Washington University, Bob Humphrey recently completed a book of "Last Elephant" cartoons. The 72-page book costs $4.95 ($4.46 for FONZ members) and is now available at the Zoo Bookstore, National Zoological Park, Washington, D.C., 20008. (If ordering through the mail, please include $1.65 postage and handling for the first book and $0.25 for each additional book to the same address. Please do not send cash, stamps, or money orders.)

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